SESSION IV
OBSTACLES TO P^2 AND HOW TO HANDLE THEM/P^2 IN HOSPITALS

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CAA-Mandated Emission Standards Effects on Medical Waste Incinerators

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Abstract:

New emission standards (Federal Register, 1997) for hospital/medical/infectious waste/ incinerators (HMIWIs) require reduced emissions of pollutants. This paper addresses technical challenges and provides a discussion of possible alternatives available to medical waste managers at DoD facilities. Waste minimization, improvements to existing incinerators, permit requirements, and relative costs are presented. In addition alternative technologies such as steam reforming are discussed.

EPA estimates that there are 2,400 existing HMIWIs. Initially EPA estimated that the proposed rule would cause 80% of existing incinerators to be shutdown. The June 1996 notice (Federal Register, 1996) presents revised impacts but does not provide a revised estimate of the number of HMIWIs that might be shutdown. The HMIWI regulations are based on the Clean Air Act Amendments of 1990 specifically requiring EPA to promulgate emission standards. The incinerator standards are based on maximum achievable control technology (MACT).

EPA requires that waste management plans identify pollution prevention measures for eliminating sources of pollutants through waste minimization and segregation. Necessary improvements to existing incinerators will vary depending on size and efficiency. Good combustion controls will be mandatory. In addition treatment of the off-gas using scrubbers and/or activated carbon adsorption may be needed. Retrofitting of older inefficient units may be too expensive compared to off-site disposal, replacement, or implementation of new technologies.

Background

In February 1995, EPA proposed new source performance standards (NSPS) based on several years of review of performance data on HMIWIs (Federal Register, 1995). These standards were

based on incinerator design differences—namely batch, intermittent, and continuous, and on results of studies of wet scrubber and dry scrubber treatment and controls of off-gas as compared to no controls. In June 1996, EPA published a re-proposal to announce availability of information and provide guidance on the potential changes to the standards (Federal Register, 1996). One of the changes was to re-categorize HMIWIs based on capacity; small (200 pounds per hour [lb/hr]), medium (201 to 500 lb/hr), and large (greater than 500 lb/hr). In addition, EPA excluded crematories and incinerators used solely for burning pathological waste, "off-spec" drugs or pharmaceuticals, and radioactive medical wastes. In the final rules (Federal Register, 1997) EPA provided for pollution prevention and waste minimization, excluded co-combustors and cement kilns, and added requirements for testing, monitoring and inspection, and operator training and qualification.

The NSPS implements sections 111 and 129 of the Clean Air Act (CAA) as amended in 1990. These standards apply to incinerators that combust any medical/infectious waste generated in the diagnosis, treatment, or immunization of human beings or animals, or in the production or testing of biologicals. Regulated entities include public and private hospitals, medical clinics, research laboratories, waste disposal companies, and health care facilities.

EPA estimates cost impacts of the MACT standards for new HMIWI to hospitals, nursing homes, etc. (Federal Register, 1997) are in the range of 0.00 to 0.16 percent of total operating costs. This translates to less than 35 cents per-patient day. Impacts to existing on-site facilities range from 0.03 to 1.70 percent of total costs. Waste minimization and total chemicals management has the potential to substantially reduce costs or provide savings in comparison to existing practices.

Regulatory

Existing sources are required to achieve MACT (lower average emissions of lowest 12% of HMIWI in category). New sources must achieve emissions control equal to the best-controlled similar unit. Table 1 is a summary of emission limits for existing and new incinerators. Small HMIWI emission limits are less stringent than medium and large units for particulate matter, dioxins, hydrogen chloride, lead, and cadmium. Existing unit emission limits are less stringent than new units for particulate matter and hydrogen chloride.

Table 2 is a summary of additional requirements, including operator training and qualifications, information and records, siting analysis, performance testing, and waste management plans.

Schedule

All new HMIWI that began construction after 20 June 1996 or existing HMIWI that began modification after 16 March 1998, are currently required to meet the federal requirements contained under subpart Ec. Existing HMIWI constructed on or before 20 June 1996 are subject to section 111(d)/129 State regulatory plans under subpart Ce (Federal Register, 1997). Table 3 is a compliance schedule. Given these time frames, it is imperative that HMIWI managers begin

evaluation and planning to avoid notice of violations for non-compliance or excessive expense for expediting improvements or contracting off-site disposal.

Waste Minimization

Reducing the volumes and toxic nature of infectious solid wastes has the potential to save money and bring existing incinerators into compliance with the new guidelines. Before making any decisions to implement new equipment or controls technologies, one must evaluate waste minimization and pollution prevention practices. It is estimated that hospitals generate approximately 1 percent of all municipal solid waste generated in the United States (AHA, 1993). Approximately 2 million tons are shipped to landfills or incinerated annually, 15 percent of which is classified as infectious waste requiring special handling. Mt. Sinai Medical Center, NY, a 1100+ bed hospital, medical school, and research facility saved over $1 million per year through implementation of a waste segregation program that went into effect in June 1989 (Bisson et al, 1993). This savings was realized largely through training of nurses and housekeepers and removal of red-bags from patient rooms.

Conducting a waste audit can identify problem areas and provide information for formulating a strategy. Determine the flow of materials from the point they enter the premises to their ultimate disposal. Look for opportunities to segregate infectious from municipal waste. Question the need for packaging and other materials. Next develop a strategy, set goals, train personnel, and implement and track progress. Chemicals management may also profoundly affect overall success in meeting emissions guidelines. Elimination of toxics such as lead, mercury, cadmium, and halogenated compounds can often lead to considerable savings and assure compliance. Sources include:
Trace metals—surgical blades, foil wrappers, plastics and inks;
Hydrochloric acid—PVC plastic bags and containers;
Mercury—dental supplies and batteries; and
Cadmium—PVC plastic bags.

An understanding of the flow and function of chemicals and the effect on incinerator performance can often lead to identification and subsequent elimination of the source.

If internal resources are not available, consider retaining qualified professionals who are experts in creating and implementing an integrated waste minimization and chemical management program and can provide a full range of services including testing, evaluation, and implementation of any necessary incinerator controls.

Evaluation

Once waste minimization effects are identified, it is time to evaluate their effect on HMIWIs. First, determine if your waste falls under the following exclusions:

Waste is entirely pathological, chemotherapeutic, low level radioactive;
Hospital waste constitutes less than 10% by weight of total being incinerated;

Waste is being used as a fuel in a cement kiln;
HMIWI is alternately being used for medical waste and municipal waste; or
Reductions of pollutants as shown in Table 1.

If the waste is not excluded, then a material balance should be prepared and a model developed to predict estimated emissions, operating range, air flows, and life cycle costs. A preliminary assessment can often be made to determine whether to continue operation, provide additional controls, or contract with an off-site treatment facility. A preliminary emissions test should then be conducted to verify/calibrate the model. Several different flow rates and temperature and air rates are recommended to determine optimum operating ranges. The model will serve as an invaluable tool in troubleshooting and projecting the effects of future changes on incinerator performance and ability to meet future compliance requirements.

Performance

Medical waste incinerators are by their nature complex and prone to upsets when improperly operated. The HMIWI is designed to reduce overall volume, destroy microorganisms, and combust organic material. Incinerator performance is a direct function of time, turbulence, temperature (the three "Ts"), waste composition, air flow, and moisture content of waste. In general, the longer the residence time, the greater the mixing and the higher the temperature, the better the destruction efficiency and volume reduction of organic waste. Most HMIWIs in operation are based on "starved air" technology. Waste is fed into a primary chamber where it is heated to between 1,400 and 1,800 (F. Air is added at 40 to 70 percent of stoichiometric to sterilize, dry, and pyrolize volatiles while minimizing ash particulate carryover into the second chamber. In the second chamber air is added at a controlled rate of 100 to 140 percent of stoichiometric and temperatures and residence time of greater than 1,800 (F and 1 second are maintained to assure combustion of volatile organic compounds and minimize formation of dioxin and furan compounds. Air velocity is typically maintained between 4 and 15 feet per second and often is added tangentially to provide a swirling air pattern to increase mixing and turbulence. The majority of the ash is removed from the primary chamber. Medical waste contains varying amounts of glass, silica, metals, and ceramics that are not oxidized and can cause formation of slag and eventually foul the combustion chamber surface if the temperature exceeds 1,800 (F.

Controls

Many incinerators will not meet the new NSPS requirements and, therefore, will require additional HMIWI air and temperature combustion and flue-gas controls if they are to remain in service. Air and temperature controls may have to be modified to allow optimum operation. Due to the variability of medical waste, the air and supplemental fuel rate and subsequent combustion efficiency can change dramatically if good continuous controls are not provided. Too little air will result in incomplete combustion and the possible formation of dioxins and furan and release of bacteria to the atmosphere. Too much air can cause carryover of particulate, reduce combustion temperature, and increase fuel use. Often the cost of tuning and addition of controls provide good return on investment with payback of capital within one year.

Flue gas controls should only be added after the effects of tuning and improvement of controls are known. Options include wet scrubber, dry scrubber with lime addition, and baghouse. Small HMIWIs will likely require venturi wet scrubbers; medium HMIWIs, a combination of dry scrubbers with lime injection, baghouse and wet scrubbing; large HMIWIs, baghouse and packed tower or sub-cooled venturi/packed tower scrubbing and most likely carbon injection (Van Remmen, 1998). Costs are estimated to range from $150,000 to $250,000 for small HMIWIs and $300,000 to $500,000 for medium and large units.

Alternatives

Alternatives to operation of on-site HMIWIs may be more cost effective and environmentally friendly. These include:
Reclassify as pathological waste, radiological waste, or pharmaceutical;
Contract off-site disposal in a permitted treatment storage and disposal facility;
Co-combust with coal;
Provide as fuel in a cement kiln; and
Use alternate technologies for sterilization and disposal.

If the HMIWI is being used exclusively for pathological, radiological, or pharmaceutical waste, it is excluded from the new guidelines.

The cost of improvements (especially older units) may not be cost effective as compared to contracting with a waste hauler that is capable of incinerating the material off site in an EPA permitted TSD facility.

If a power plant or cement kiln is in the area, the potential exists that they can use the waste as a fuel.

Other technologies may be more cost effective than incineration. Following are a number of technologies for consideration:

Steam Sterilization—autoclave sterilization at a temperature of at least 275(F temperature to kill bacteria, followed by grinding and combination with other wastes to make it indistinguishable when disposed of at a municipal landfill;
Steam Reforming—destruction and volume reduction using high temperature steam at 1,200 (F;
Pyrolysis—heat to above 600(F in the absence of air to drive volatiles off followed by combustion as a fuel at greater than 1,800(F;
Vitrification—heat to 3,000(F using plasma or other means in a chamber without air to form gases and molten glass;
Infrared—use of far infrared rays to kill micro organisms followed by shredding and disposal at landfill; and
Microwave—shredding of material followed by steam and microwave treatment.

A life cycle cost assessment should be conducted prior to selection of the final remedy.

Summary

The new NSPS for HMIWIs will require careful planning and evaluation to avoid penalties for non-compliance. Managers responsible at DoD hospitals and medical facilities will need to become familiar with the new regulations and determine if their HMIWIs are excluded, whether additional controls are needed, or whether they should be shutdown and waste disposal be contracted through a waste hauler with permitted TSD facilities. Waste minimization of infectious waste can provide excellent value and has potential to bring existing HMIWIs into compliance. To be successful it is important to get an early start in funding, planning, and evaluation at hospitals and medical facilities.

References:

Bisson, L.B., McRae, G., Shanner, H.G., 1993. An Ounce of Prevention, Waste Reduction Strategies for Health Care Facilities, American Hospital Association.

Federal Register, 1995. 61 FR 31734-31779. June.

Federal Register, 1996. 61 FR 3173C. June.

Federal Register, Part II, EPA, 1997. 40 CFR Part 60, 15 September.

Van Remmen, T., 1998. Evaluation of the Available Air Pollution Control Technologies for Achievement of the MACT Requirements in the Newly implemented New Source Performance Standards (NSPS) and Emissions guidelines (EG) for Hospital and Medical/Infectious Waste Incinerators, presented at the IT3 Conference, Salt Lake City, UT, May.

Radian Corporation, 1987. Hospital Waste Combustion Study Data Gathering Phase Final Draft Report, DCN 87-239-001-30-06. Prepared for Ray Morrison, submitted to EPA. October.

Table 1. Emission Levels Established for HWI Units Under 40 CFR 60 Subpart Ce and Ec

Pollutant
(Test Method) Small HMI Medium HMI Large HMI
New Existing
Rural Existing
Urban
New
Existing
New
Existing Particulate Matter (gr/dscf)
(EPA Method 5 or Method 29) 0.03 0.086 0.05 0.015 0.03 0.015 0.015 Carbon Monoxide
(ppmv)
(EPA Method 10 or Method 10B) 40 40 40 40 40 40 40 Dioxins/Furans (ng/dscf)
(EPA Method 23) 125
800 125 25 125 25 125 Hydrogen Chloride (ppmv) (EPA Method 26) 15
or 99%
reduction 3,100
100
or 93%
reduction 15
or 99%
reduction 100
or 93%
reduction 15
or 99%
reduction 100
or 93%
reduction Sulfur Dioxide (ppmv)
(testing not required) 55 55 55 55 55 55 55 Nitrogen Oxides (ppmv)
(testing not required 250 250 250 250 250 250 250 Lead (mg/dscm) (EPA Method 29) 1.2
or 70%
reduction 10 1.2
or 70%
reduction 0.07
or 98%
reduction 1.2
or 70%
reduction 0.07
or 98%
reduction 1.2
or 70%
reduction Cadmium (mg/dcsm)
(EPA Method 29) 0.16
or 65%

reduction 4 0.16
or 65%
reduction 0.04
0.16
or 65%
reduction 0.04 0.16
or 65%
reduction Mercury (mg/dcsm)
(EPA Method 29) 0.55
or 85%
reduction 7.5 0.55
or 85%
reduction 0.55
or 85%
reduction 0.55
or 85%
reduction 0.55
or 85%
reduction 0.55
or 85%
reduction Source: 40 CFR 60 Subpart Ce and Ec.

Table 2. Summary of Additional Requirements Under the Emission Guidelines
Additional Requirements

Operator Training and Qualifications Requirements:
Complete HWI operator training course,
Qualify operators,
Maintain information regarding HWI operating procedures and review annually.
Inspection Requirements:
Provide for an annual equipment inspection of the designated facility.
Waste Management Plan:
Prepare a waste management plan that identifies the feasibility and approach to separate certain components of a health care waste stream.
Compliance and Performance Testing Requirements:
Conduct an initial performance test to determine compliance with the PM, CO, CDD/CDF, HCl, Pb, Cd, and Hg emissions limits and opacity limit, and establish operating parameters.
Conduct annual performance tests to determine compliance with the PM, CO, and HCl emission limits and opacity limit.

Table 2. (Continued)
Additional Requirements Facilities may conduct performance tests for PM, CO, and HCl every third year if the previous three HWI performance tests demonstrate that the facility is in compliance with the emission limits for PM, CO, or HCl.
Perform annual fugitive testing (large, new HWI).
Monitoring Requirements:
Install and maintain equipment to continuously monitor operating parameters including secondary chamber temperature, waste feed rate, bypass stack, and APCD operating parameters as appropriate.
Obtain monitoring data at all times during HWI operation.
Reporting and Record Keeping Requirements:
Maintain for 5 years records of results from initial performance test and all subsequent performance tests, operating parameters, any maintenance, the siting analysis, and operator training and qualification.
Submit the results of the initial performance test and all subsequent performance tests.
Submit reports on emission rates or operating parameters that have not been recorded or that exceeded applicable limits.
Provide notification of intent to construct, construction commencement date, planned initial start-up date, planned waste type(s) to be combusted, the waste management plan, and documentation resulting from the siting analysis for new HMIWI. Note: This table depicts major provisions of the NSPS. Refer to final guideline Subpart Ce and Ec for complete requirements.

Table 3. Compliance Schedule:
Requirement New HMIWI Existing HMIWI* Effective Date 20 June 1996 September 15, 1998 Operator training & qualifications Initial startup Within one year of approval of State plan Inspection requirements Within one year of approval of State plan Initial compliance test 180 day from initial startup Within one year of approval of State plan or up to 3 years after EPA approval of State plan if the source is granted an extension. Performance test Within 12 months of initial compliance test and annually thereafter. Every third year if the three previous annual tests demonstrate compliance Within 12 months following initial compliance test and

annually thereafter Parameter monitoring Continuous Continuous Record keeping Continuous Continuous Reporting Annually, semiannually if not compliant Annually, upon completion of initial compliance test; semiannually, if not compliant *Note: State plans for existing HMIWIs are due September 15, 1998. The Federal EPA is required to approve or disapprove these plans within 6 months. If a plan is disapproved, reasons are published in the Federal Register and the State can submit a revised plan. If the plan is not approved on or before September 15, 1999, Federal EPA will implement a plan.